SONDAR4000

Ultrasonic Sludge Density Meter

User Manual V.3.8

IS Technologies Co., Ltd.

SONDAR 4000

Aug. 2003

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TECHNICAL ENQUIRIES

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1. Product Information

Introduction

Sondar 4000 is an in-line sludge density meter measuring the density of sludge flowing in the pipe in the manner of ultrasonic attenuation method.

Since the user can adjust the setting range of current output and relay, it allows active generation of alarm and control inside the processor.

Sondar 4000 satisfies the waterproofing requirements of IP65, displays the density value at a graphic LCD, and has 5 buttons for various setting.

Features

- Insertion of sensor into pipe allows in-line density measurement and it can be applicable to various kinds of sludge.
- It measures the temperature of target medium for temperature compensation, resulting in more accurate measurement.
- Measured sludge density is displayed in digital mode (% or mg/L).
- Current output (4 mA ~ 20 mA) in proportion to measured sludge density.
- Able to set the sludge density corresponding to output of 4 mA and 20 mA.
- Having two separate SPDT relays that the user can freely set.
- Depending on setting conditions, abnormal current output (3.8 mA or 21 mA) can be resulted on wrong operation, enabling remote detection of such wrong operation.
- All functions can be operated only with 5 buttons.
- The setting values are saved at EEPROM, so they are maintained even when the power is cut.
- Free voltage

Specifications

Physical

Controller	191×240×133mm
Sensor	Depends on pipe size
Weight	Around 3.5kg (controller)
Sensor Material	S.S,316
Range	0~2, 5, 10, or 20% solids

Environmental

IP Rating (electronics housing)	IP65(Controller)
Max. & Min. temperature (electronics)	-20 ºC to +60 ºC(Controller), -30 to +80°C(Sensor)
RTX cable length	7m (Standard)

Performance

Accuracy	0.5% of full scale
Range(pipe diamenter)	80A~600A
Frequency	1 MHz
Displayed Information	Density, Temperature, Alarm, Statue Graphic LCD
Temperature Compensation	Fully compensated via integral temperature sensor over entire operational span

Outputs

Analogue output	4-20mA into Max 750Ω (user adjustable: 250Ω) Fault condition alarm 3.8mA /Hold/21mA,
Setpoint Relay	2 SPDT Relays
Relay capacity	5A, AC250V
Communication Port	1 point RS-232C/RS-485(Option)

Programming

On-board programming	via 5 tactile push button buttons

Supply

Power supply	AC 90 ~ 260V, Less than 15VA(50Hz ~ 60Hz), DC24V(Option)

Applicable Channel

Sewage treatment plant: raw sludge line, excess sludge line, concentrated sludge line
Wastewater treatment: return sludge line, digested sludge line
Chemical process, Pulp paper mill, Concentration process

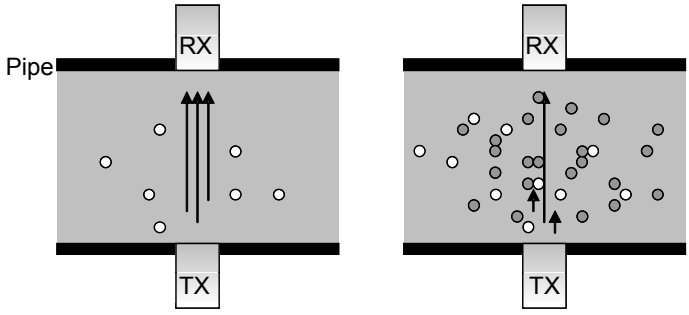
Measurement Principles

In general, an ultrasonic density meter measures the density of a medium based on the attenuation degree of received signals relative to transmitted signals.

As shown in the below figure, presence of particles in a medium results in scattering of ultrasonic waves passing the medium, leading to reduction of received signals. Such attenuation of received signals is used to determine the density of dissolved material, suspended solids, or organic solution.

At present, the ultrasonic density meter is used in the fields of wastewater treatment, livestock waste treatment (sludge), pulp, and paper mill. Further, it has been increasingly used at various food and chemistry processes.

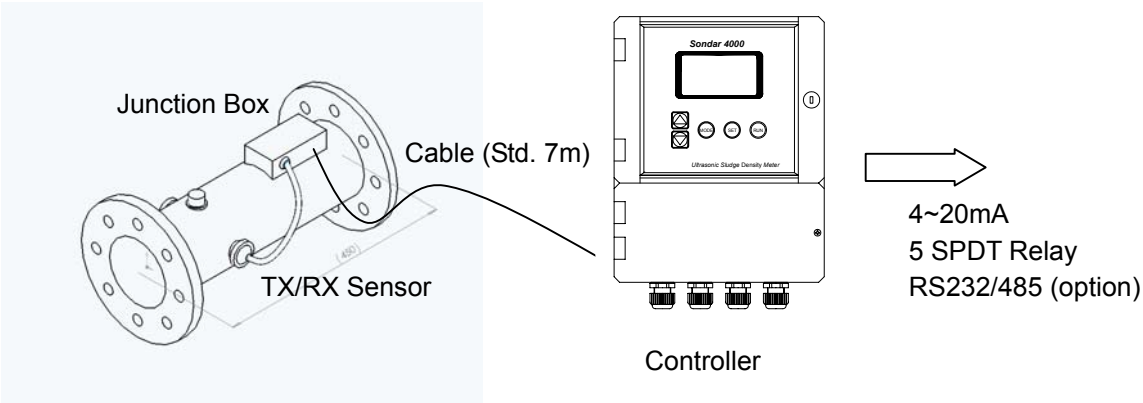
It has the advantages of in-line density measurement without interference of flow as well as easy maintenance. Since lots of bubbles can also disperse the ultrasonic signals and result in high-density value, careful attention should be paid to occurrence of bubbles. In this case, a process of removing bubbles in the manner of compression or with use of magnetism can be added to get more accurate result.



< Principle of Ultrasonic Density Meter >

Structure

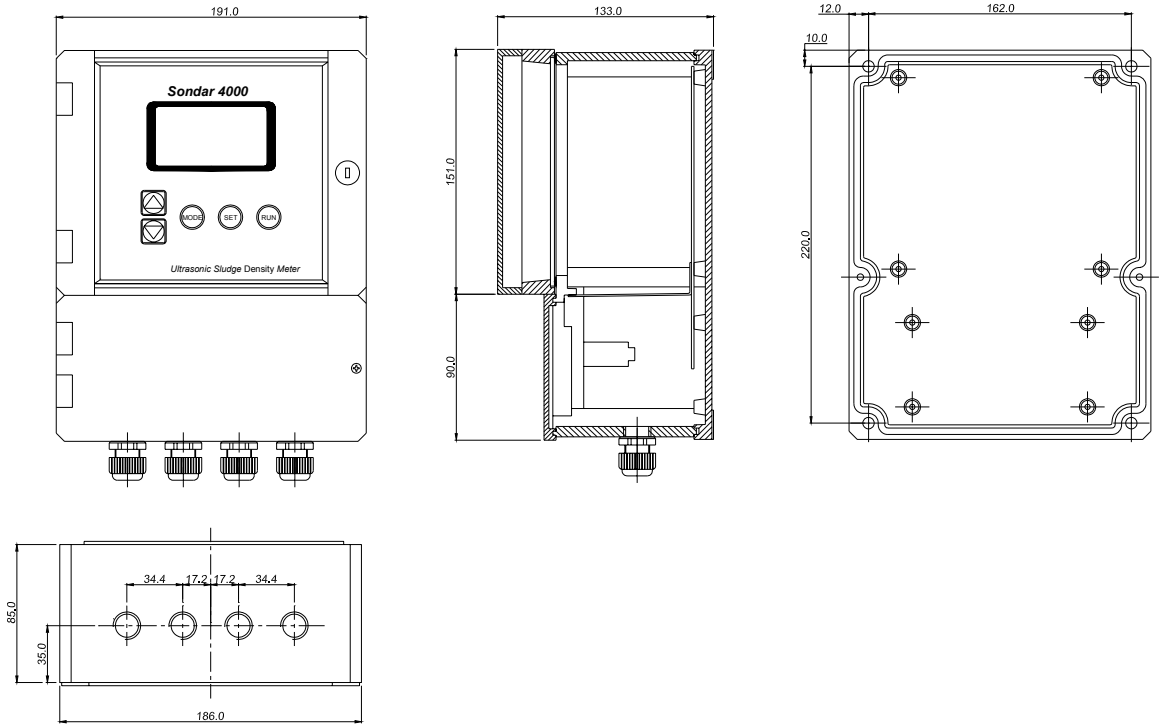
A sensor is inserted into the pipe and the sensor cable is connected to a controller through a junction box. The controller controls the process according to the density-linked current output, alarm, and error relay output.



2. Installation

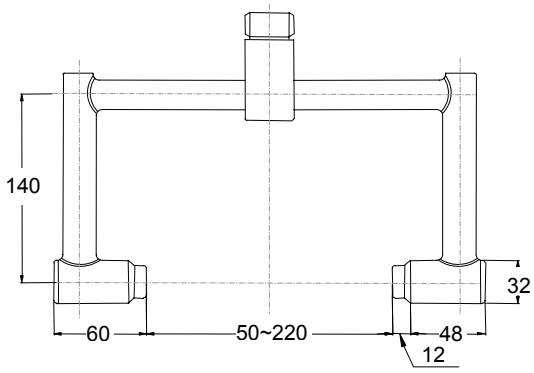
Dimension

Controller



<Front & Base> <Side> <Back>

Sensor



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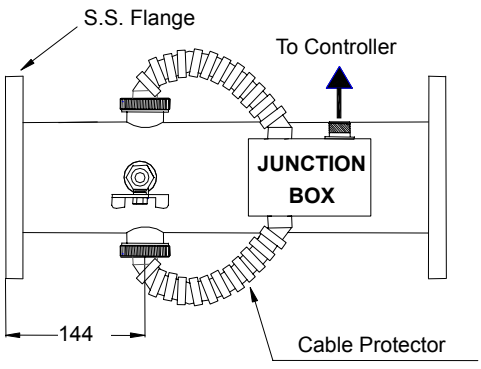
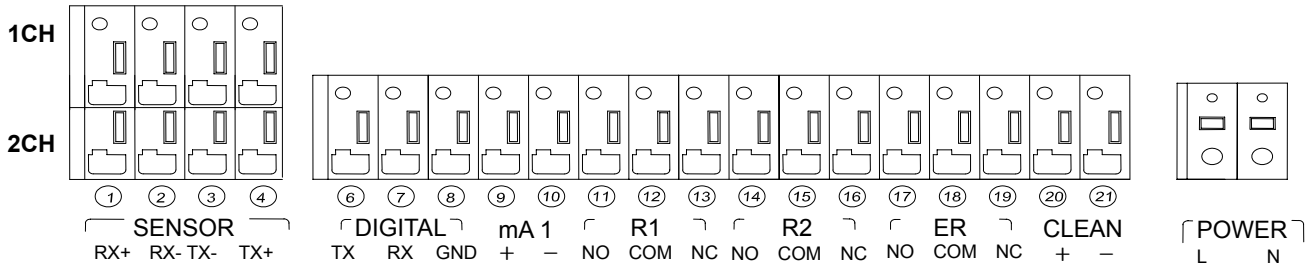


<Pipe Type>

Cable Connection

Open a base cover and 23(27) terminals in one row are shown as follow:

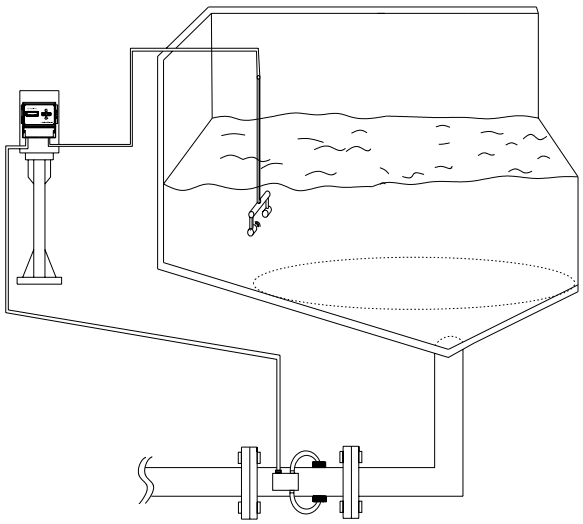


<Input & Output Terminals>

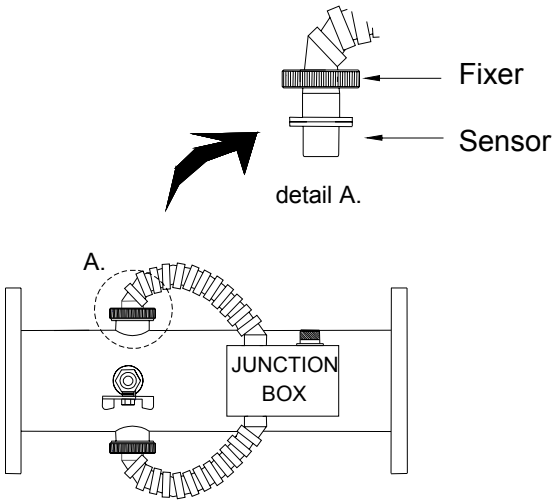
Terminal	Terminal	Function	Remark
(1)	RX+	RX sensor's signal output wire connection	
(2)	RX-	RX sensor's GND wire connection	
(3)	TX-	TX sensor's GND wire connection	
(4)	TX+	TX sensor's signal output wire connection	
(5)	VCC	DC power	
(6)	TX	When using RS232C, RS232C transmission connection/When using RS485 interface, Y connection	Option
(7)	RX	When using RS232C, RS232C receipt connection/When using RS485 interface, Z connection	Option
(8)	GND	GND for digital communication	
(9)	mA+	Current output. 4~20mA outputs in proportion to density	Max.750Ω
(10)	mA-	Current output return	
(11)	R1_NO	Alarm1 Relay's NO contact. On Relay operation, it shorts with A1_COM.	
(12)	R1_ COM	Alarm1 Relay's COM contact.	
(13)	R1_ NC	Alarm1 Relay's NC contact. When Relay does not operate, it shorts with A1_COM.	
(14)	R2_NO	Alarm2 Relay's NO contact. When Relay operates, it shorts with A_2 COM.	
(15)	R2_ COM	Alarm2 Relay's COM contact.	
(16)	R2_ NC	Alarm2 Relay's NC contact. When Relay does not operate, it shorts with A2_COM.	
(17)	ER_NO	Fail Relay's NO contact. In the case of fail, it shorts with FA_COM.	
(18)	ER_ COM	Fail Relay's COM contact.	
(19)	ER_ NC	Fail Relay's NC contact. When Relay does not operate, it shorts with FA_COM.	
(20)	CLAEN+	Solenoid Valve SSR(+) contact	
(21)	CLEAN-	Solenoid Valve SSR(-) contact	
	L, N	AC power input	AC90~260V

Installation

The following figures show the installation example.



<Installation Diagram>



<Sensor Installation>

Installation Procedures

1. Pipe installation:
   - For stable flowing, installation should be conducted at a place distant from bent or expanded portions (more than 5D).
   - Since accurate measurement is possible when the pipe is fully filled, installation should be conducted to make the flow direction of bottom-up or to make the sensor connection axis run parallel with the ground.
2. Sensor installation:
   - Remove any foreign or projected materials in the sensor fixation part in order to prevent any damage in the course of sensor insertion.
   - Check if there is O-ring in the sensor fixation part.
   - Insert the sensor and completely fix it with use of a fixer.
3. Cable connection:
   - Use a specified cable to connect Junction Box with Controller.
   - Connect Controller's terminals

Important information

When installing the sensor, be sure to check if Junction Box and Controller have the same S/N (shown on their labels). In the course of product release, zero setting and sensitivity adjustment were conducted to reflect the installation conditions. Therefore, Controller and sensor with the same S/N have to be connected. If normal temperature values are not displayed, check if RX and TX sensors are correctly connected or TX sensor is damaged. TX sensor has the temperature sensor.

Zero Setting & Span Setting

Calibration Procedures

1. Press MODE button at operation mode
2. Go to option No. 18, by pressing Up/Down button

```
  17. ZERO ADJ

*18. AUTO ZERO ADJ

  19. SAPN ADJ

  20. SPAN OFFSET ADJ
```

Important information

* It is desirable to set 2- or 3-time value of average density as max. density.
* Since presence of bubbles results in inaccurate measurement, be sure to remove all bubbles if possible.
* If there is a dramatic inflow of sludge into the pipe, accurate measurement can be done only after the flow is stabilized.

Zero Setting

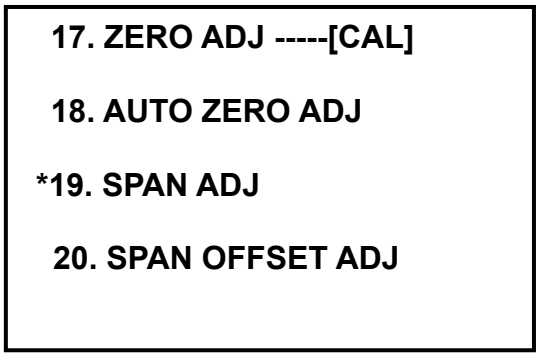
1. Fill the pipe with clear water and wait about 10 minutes until the flow becomes stabilized.
2. By pressing SET button, zero adjustment starts automatically.

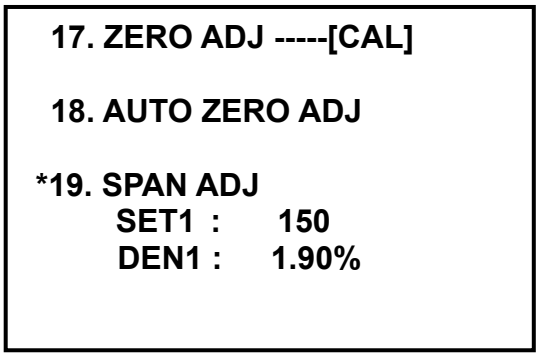
```
AUTO ZERO
      ADJUSTING……

SETTING  :    150
C_COUNT :   3860
Auto SET? SET, NO? DOWN
VOLTAGE  :  2.30V
DENSITY  :  9.38%
```

- When the output voltage is close to within 1%, Auto SET? SET, NO? DOWN message will display.
- Press SET button when the percentage is close to 0%.
- Press DOWN button when the additional adjustment requires.

Span Setting

1. Introduce the sludge into the pipe and wait about 10 minutes until the flow becomes stabilized.
2. By pressing SET button, SPAN ADJ. option is shown as below figure.
3. Use Up/Down button to set the DEN: **.**% valve at desired level.
4. Press SET button to save the SPAN ADJ. value





3 How To Use

Controller

Open a base cover of Controller and 3 terminal blocks will be shown. A sensor signal wire is connected to Rx/Tx sensor connection terminal. A control output and a current output are connected to control terminal, while a power input is connected to power terminal.

Button

□ **MODE Button**

This button has a function of converting Operation Mode to Program Mode. Push of this button at Operation Mode will show the options for Program Mode. Then, use UP or DOWN button to go to other options.

△ **UP / ▽ DOWN Button**

This button is used to change the setting value of an option selected by Mode button. One push results in increase by "1" unit, while continuous push results in continuous increase. Change of more than 10 from the initial value makes change of ten figures. At more than ten figures, 100 figures are changed. When Program Mode is not selected, it is used for movement of option items.

□ **SET Button**

This button is used to change the setting values and save such changed values of option selected. Also, it is used for movement of option items.

□ **RUN Button**

Push of this button results in return to Operation mode from Program Mode.

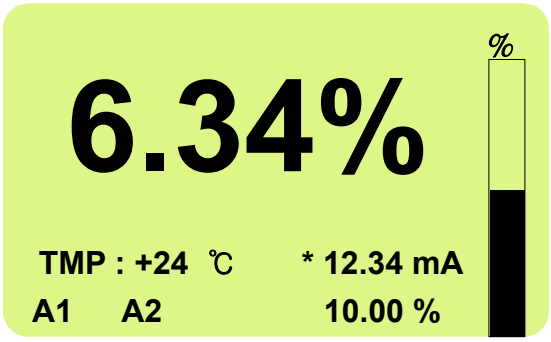
Operation Mode

There are two modes: Program Mode and Operation Mode. Program Mode is activated by Mode button, while Operation Mode is activated by Run button.

At Program Mode, the values are set by Up or Down button. After completion of setting, push Set button to save the setting values. Then, use Up or Down button to go to other option items or push Run button to go back to Operation Mode.

1) LCD Display at Operation Mode

LCD shows the following display at Operation Mode.



< Display at Opeation Mode >

(1) □□.□□% - This indicates the density under measurement.

(2) TMP: □□℃ - This indicates the inside temperature. Since the temperature sensor is in the inside of TX sensor, this means actual temperature of fluid under measurement.

(3) 00.00mA - This indicates current ouput of density

(4) Bar graph - This indicates a percentage of current density relative to maximum density. For example, if the current density is 5% and max. density set by the user is 10%, the bar graph shows 50% of full length.

(5) A1 A2 FAIL - A1 means that ALARM 1 RELAY is in operation, while A2 means that ALARM 2 RELAY is also in operation. FAIL is shown when the device is in abnormal operation. However, when FAIL is indicated, max. density is displayed.

(6) FS: □□.□□% - This indicates max. measurable density.

(7) TIME : - Month, Date, Year, Hour, Minute

2) Alarm Relay Operation

When the measured density reaches the specified Alarm density, the built-in Alarm Relay operates to make output contact On or Off. The Alarm density can be set by the user.

Depending on the user's needs, RELAY 1 and 2 can be used for low-density alarm, high-density alarm, control of sludge feed pump according to density, or control of sludge discharge pump.

Example 1: When Alarm 1 Relay is used for control of sludge feed pump

When 1.00% is set for Alarm 1 Relay On and 5.00% is for Alarm 1 Relay Off, the relay is On when actual density becomes less than 1.00%. In this case, the sludge feed pump is also turned on, leading to increase of density. Then, if the density reaches 5.0%, the relay is Off to stop the pump.

Example 2: When Alarm 2 Relay is used for control of sludge discharge pump

When 8.0% is set for Alarm 2 Relay Off and 9.0% is for Alarm 2 Relay On, the relay is On when actual density is more than 9.0%. In this case, the sludge discharge pump is also turned on, leading to decrease of density. Then, if the density reaches 8.0%, the relay 2 is Off to stop the pump.

3) Current Output and Alarm On Wrong Operation

When the device does not normally operate, a specific current output (selected by the user among three options; 3.8 mA, Hold, or 21 mA) different from those under normal operation is resulted, leading to operation of a relay for alarm of wrong operation. As a result, the fact of wrong operation is informed to a remote operator.

4) Sensor Cleaning

Attachment of sludge to the sensor surface can affect actual measurement, so periodic cleaning of the sensor surface is required. Sensor can be cleaned according to a specific period set by the user.

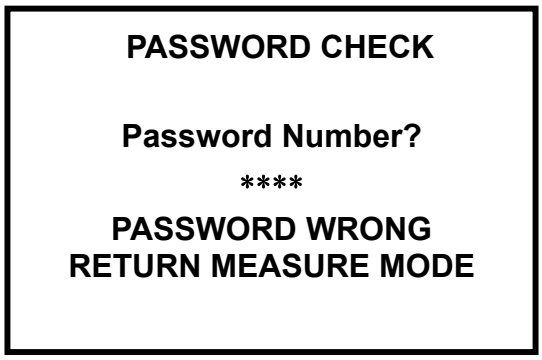
Sensor is cleaned by operating the electronic SOL VALVE and spraying high-pressure water over the sensor surface.

At a specified cleaning time set by the user, the density meter's SOL1 and SOL2 contacts become ON, leading to operation of the electronic SOL VALVE.

Setting Mode

Password Check Mode

When the password is confirmed



When the password is wrong

Push of Mode button enters Password Check Mode. This is to prevent unauthorized change of setting values. If wrong password is entered, a message of "**PASSWORD ERROR!**" and a message of "**RETURN OPER. MODE**" are displayed at the same time. Then, the mode is returned to Operation Mode. When the password is confirmed, a message of "**PASSWORD OK!**" is displayed and you can go to next control mode.

4 Programming

Change of Set Values

Push Set button at the relevant option and the corresponding set value will be displayed. Push Set button again and * will be indicated in front of the relevant option, which will be saved. Then, use Up or Down button to move to other option.

Password Change

Factory Set= 0

***01. PASSWORD**
02. UNIT SET
03. LOWCUT DENSITY
04. SPAN SCALE

-This option is to change password.
-Push Set button and use Up or Down button to set the desirable password.
-After password setting, push Set button and use Up/Down button to move to other option.
☞ (Mode → Set→ UP or DOWN→Set)

Display Unit

Factory Set= %

01. PASSWORD
***02. UNIT SET**
03. LOWCUT DENSITY
04. SPAN SCALE

-This option is to choose the density display unit.
-Push Set button and use Up or Down button to select % or mg/L.
-After setting, push Set button and use Up/Down button to move to next option.

Low Cut

Factory Set= 0.50%

01. PASSWORD
02. UNIT SET
***03. LOWCUT DENSITY**
04. SPAN SCALE

- This option is to set min.density value display in LCD. Lower than this values will be displayed as 0%
- Push Set button and use Up or Down button to set the value.

Span Scale

Factory Set= 10.00%

01. PASSWORD

02. UNIT SET

03. LOWCUT DENSITY

***04. SPAN SCALE**

- This option is to set maximum density value.
- Push Set button and use Up or Down button to set maximum density value.
- It is desirable to set 3- to 4-time value of average density as max. density value.

4 mA Set Point

Factory Set= 0.00%

***05. 4mA SET POINT**

06. 20mA SET POINT

07. OUPUT DAMPING

08. FAIL SAFE CURRENT

- This option is to set 4 mA output density value.
- Push Set button and use Up or Down button to select 4mA output density.
- After setting, push Set button and use Up/Down button to move to next option.

20 mA Set Point

Factory Set= 0.00%

05. 4mA SET POINT

***06. 20mA SET POINT**

07. OUPUT DAMPING

08. FAIL SAFE CURRENT

- This option is to set 20 mA output density value.
- Push Set button and use Up or Down button to select 20 mA output density.
- After setting, push Set button and use Up/Down button to move to next option.

Output Damping

Factory Set= 10Sec

05. 4mA SET POINT

06. 20mA SET POINT

***07. OUPUT DAMPING**

08. FAIL SAFE CURRENT

- This option determines the maximum rate at which the unit will respond to an increase/decrease in sludge density.
- Set longer time when the density is not stable
- Range : 1~1000sec

Fail Safe Current

Factory Set= 3.8mA

05. 4mA SET POINT

06. 20mA SET POINT

07. OUPUT DAMPING

***08. FAIL SAFE CURRENT**

- This option is to set fail-safe time.
- Push Set button and use Up or Down button to set value among 3.8/Hold/22mA

RELAY1 On Set

Factory Set= 1.0%

***09. RELAY1 ON**

10. RELAY1 OFF

11. RELAY2 ON

12. RELAY2 OFF

- This option is to set Relay 1 Relay On.
- Push Set button and use Up or Down button to set density value.
- It is desirable to set density value under consideration of connection device and control method.

RELAY1 Off Set

Factory Set= 1.5%

09. RELAY1 ON

***10. RELAY1 OFF**

11. RELAY2 ON

12. RELAY2 OFF

- This option is to set Relay 1 Relay Off.
- Push Set button and use Up or Down button to set density value.
- It is desirable to set density value under consideration of connection device and control method.

RELAY2 On Set

Factory Set= 9.0%

09. RELAY1 ON

10. RELAY1 OFF

***11. RELAY2 ON**

12. RELAY2 OFF

- This option is to set Relay 2 Relay On.
- Push Set button and use Up or Down button to set density value.
- It is desirable to set density value under consideration of connection device and control method.

RELAY2 Off Set

Factory Set= 8.5%

09. RELAY1 ON

10. RELAY1 OFF

11. RELAY2 ON

***12. RELAY2 OFF**

- This option is to set Relay 2 Relay Off.
- Push Set button and use Up or Down button to set density value.
- It is desirable to set density value under consideration of connection device and control method.

Select Detector

Factory Set= CH1

***13. SELECT DETECTOR**

14. DATA INTERVAL

15. DATA TREND

16. TRANSMIT POWER

- This option is to set the measuring channel.
- This option is used only for dual channel model

.

Data interval

Factory Set= 1min

13. SELECT DETECTOR

***14. DATA INTERVAL**

15. DATA TREND

16. TRANSMIT POWER

- This option is to set inverval of data saving. (1, 5, 10, 30, 60, 120min)
- Presently saved data is removed once change this value
- The value becomes the space when check the density trend.

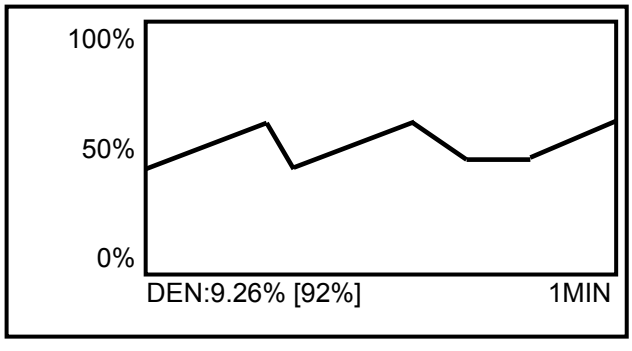
Data trend

13. SELECT DETECTOR

14. DATA INTERVAL

***15. DATA TREND**

16. TRANSMIT POWER



- To display the density trend.
- Display 100-point data and the interval of each point is set at precious option No. at 14
- The upper right figure shows the density trend in percentage relative to full scale

Transmit Power

Factory Set= 1min

13. SELECT DETECTOR

14. DATA INTERVAL

15. DATA TREND

***16. TRANSMIT POWER**

- This option is to set the strength of sensor power
- When small size of pipe in use, set the value small, and vice versa.

Note!!

Need to adjust zero and span set again, if this valve is changed.

Zero Adjust

Factory Set= 100

***17. ZERO ADJ.**

18. AUTO ZERO ADJ.

19. SPAN ADJ.

20. SPAN OFFSET ADJ.

- This option is to adjust/change the zero value manually.
- This option is to adjust the amplification ratio of intial signal reception
- The amplification ration goes up relative to set value
- Range : 1~255

Auto Zero Adjust

Factory Set= 100

17. ZERO ADJ.

***18. AUTO ZERO ADJ.**

19. SPAN ADJ.

20. SPAN OFFSET ADJ.

- This option is to adjust the zero value automatically, if this value is changed
- Refer to Zero and Span setting at page 10.

Span Adjust

Factory Set= 0

17. ZERO ADJ.

18. AUTO ZERO ADJ.

***19. SPAN ADJ.**

20. SPAN OFFSET ADJ.

- This option is to adjust the span amplification ratio
- Refer to Zero and Span setting at page 10

- Range : 0~255

Span Offset Adjust

Factory Set= 0%

17. ZERO ADJ.

18. AUTO ZERO ADJ.

19. SPAN ADJ.

***20. SPAN OFFSET ADJ.**

[D1]

17. ZERO ADJ.

18. AUTO ZERO ADJ.

19. SPAN ADJ.

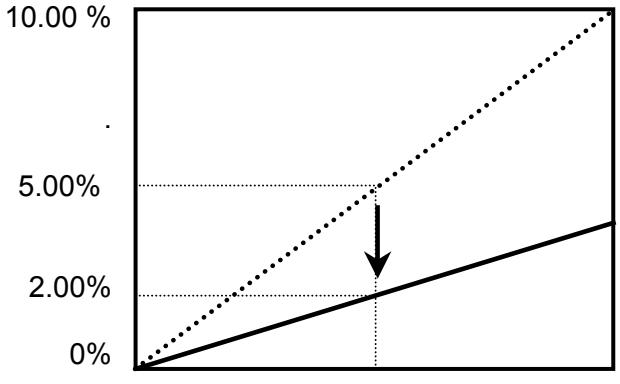
20. SPAN OFFSET ADJ.

X.XX% -------> 0.00%

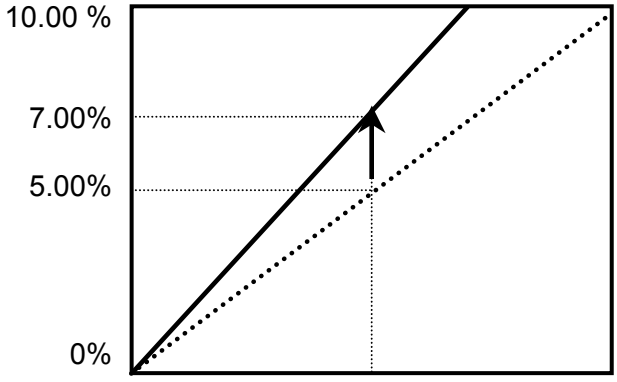
[D2]

- This option is to compensate the density curve when the change of density is not linear against ultrasonic attenuation. The present span density(X.XX%) will be shown on the left. The right 0.00% is flickering for desired span value setting.

[Ex. I] 5.00% -----> 2.00 %



[Ex. II] 5.00% -----> 7.00 %



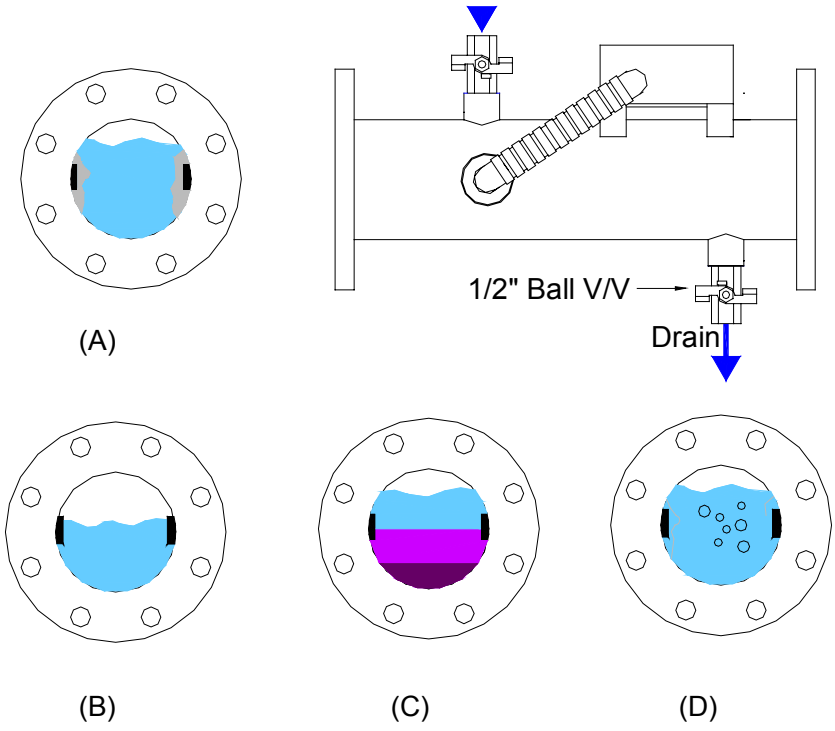
5. Maintenance

Maintenance

1) Controller – Install it at a clean place without dust, particles, or other foreign materials, if possible, and use the fine cloth to clean it.
2) Sensor – It is recommended to periodically check the cleanliness of the sensor surface. Clean the sensor based on the user's experience. When the density of more than average value is displayed, be sure to check the cleanliness.
3) Cable – Do not allow it to come into contact with solvent or chemicals. Place it at a place distant from the motor, big machine, or others generating electric noise.

As shown in the below figures, when viscous materials are attached to the sensor (A), target medium does not go up to the level of sensor (B), foreign materials are accumulated to block the sensor surface due to low fluid speed (C), or there are lots of bubbles (D),

It is not possible to conduct normal measurement. Therefore, careful attention should be paid to cleanliness of pipe and sensor. Further, appropriate actions should be taken to avoid bubbles for more accurate measurement.



6. Troubleshooting

If there are any wrong operations during installation or use of Sondar 4000 Ultrasonic Sludge Density Meter, please refer to the following table.

Items	Problems	Solutions	Remark
LCD Display	1. Display is off. 2. Display flickers.	* It is a problem of power supply to display board. 1) Check the power connection. 2) Check the flexible cable connection at the rear. 3) Check the flat cable connection between main board and display board.	
	3. Display is not clear.	* It is a problem of LCD contrast adjustment. 1) Check the cable connection and separate the display board to adjust the volume resistance.	
Current Output	1. The current output does not match with the density value.	* The current output is displayed after conversion of digital value to analog one. The current value can be compensated at Engineering Mode. 1) Check mA Setpoint setting at Option 5 & 6.	
	2. Current output adjustment	1) Compensate the current output at Engineering Mode 2.	
	3. The current output does not work.	* The lightening or wrong connection of polarity can damage the current output element. 1) Check the connection status of current output terminal block. 2) When the connection is correct, contact us.	
Density Display Value	1. Display value is 0%.	* Since display value is a relative one, wrong adjustment of ZERO ADJ in circuit may affect the display value. 1) Re-adjust Zero and Span setting. 2) When such condition is not corrected, contact us.	
	2. Display value is Full value.	* When foreign materials are attached to the sensor surface, measurement is not possible. Or when there is no RX signal due to wrong connection of sensor wires, only full value is displayed. 1) Check if temperature value is normally displayed. 2) Check the connection of sensor. (cable) - If there is no problem of sensor connection, such display of only full value may be resulted from attachment of foreign materials to the sensor surface. 3) Check the cleanliness of sensor.	
	3. Display value is not stabilized.	* When the sensor surface is not clean or the sensor connection is not stable, RX signal is also unstable. 1) Check the cleanliness of sensor. 2) Adjust Damping rate.	
Temp. Display Value	1. (-) value of temp. is displayed.	* Since temperature is used for density compensation, temperature measurement should be normally continued. 1) Check the sensor connection at TX.	
	2. Temp. unstable change.	1) Contact us	

7. Option Records

SONDAR 4000

No	Items	Setting	Range	Initial Values
01	PASSWORD CHANGE		0~1000	0
02	DISPLAY UNIT		%, mg/L	%
03	LOWCUT DENSITY		0.00% ~ Max. Density	0.1%
04	SPAN SCALE		0.00% ~ Max. Density	10%
05	4mA SET POINT		0.00%~ Max. Density	0%
06	20mA SET POINT		0.00%~Max. Density	10%
07	OUTPUT DAMPING		1 ~ 1000 sec.	100 sec.
08	FAIL CURRENT		3.8mA/Hold/21mA	3.8mA
09	RELAY1 ON		0.00% ~ Max. Density	1%
10	RELAY1 OFF		0.00% ~ Max. Density	1.5%
11	RELAY2 ON		0.00% ~ Max. Density	9.0%
12	RELAY2 OFF		0.00% ~ Max. Density	8.5%
13	SELECT DETECTOR		Present Time	
14	DATE INTERVAL		30sec.1minute, 5, 20,30 minutes	1 minutes
15	DATA TREND			
16	TRANSMIT POWER		1 ~ 100	10
17	ZERO ADJ		0 ~ 255	
18	AUTO ZERO ADJ			
19	SPAN ADJ		0 ~ 255	
20	SPAN OFF ADJ		0.0V ~ 2.5V 0.0% ~ Full Scale	0.0V 0.0%